



Armed Forces College of Medicine AFCM



Reflex Action And Its Properties

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INTENDED LEARNING OBJECTIVES (ILOs)



By the end of this lecture the student will be able to:

1. Define reflex arc
2. Identify components and types of reflex arc
3. Explain the properties of reflex action.

Reflex Arc



• Definition:

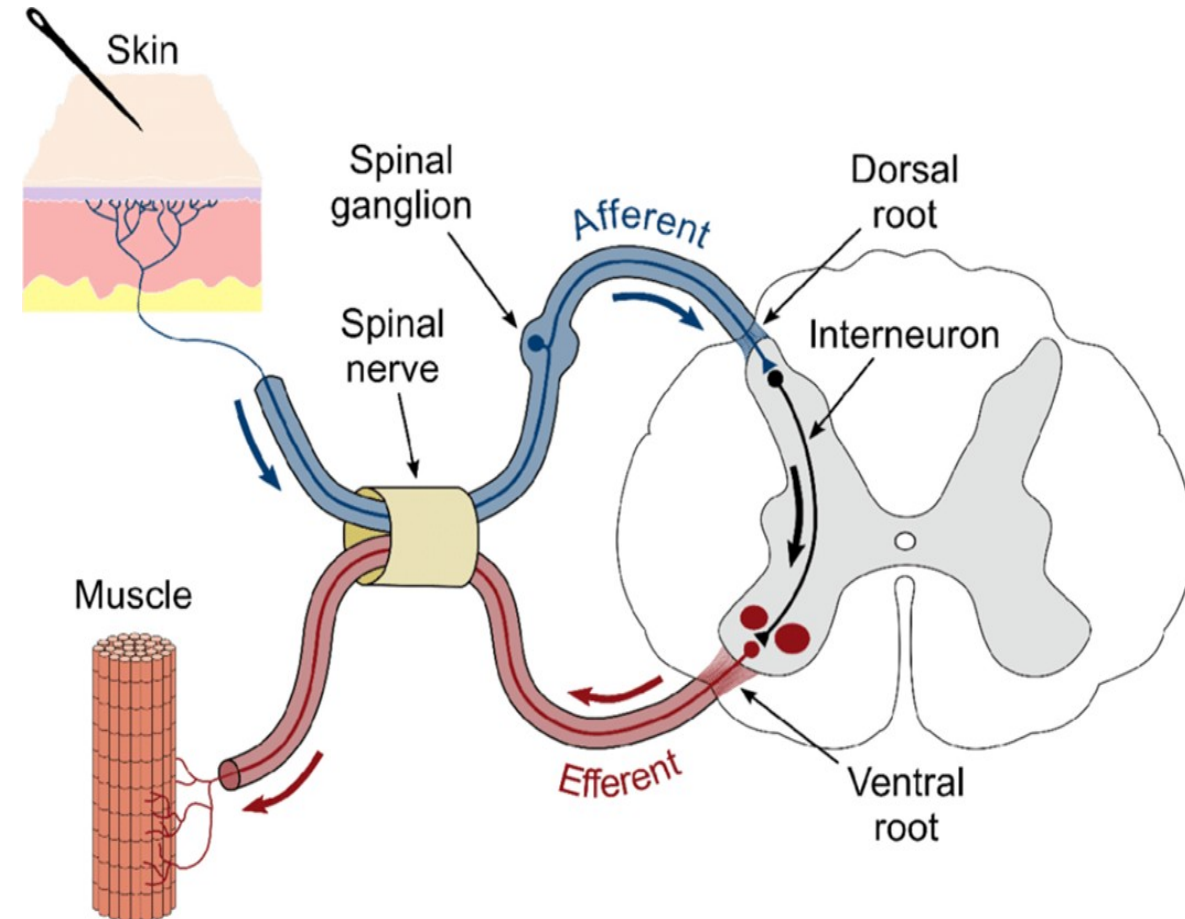
It is the basic unit of integrated reflex activity.

• Components:

Receptor,
Afferent,
Center (Interneuron)
Efferent
Response (effectors organ)

• Bell Magendi Law:

The dorsal root is sensory, while the ventral root is motor.



https://www.researchgate.net/figure/Schematic-representation-of-a-spinal-reflex-arc-A-pi-in-the-skin-produces-an-input_fig1_327199446

Reflex Arc



• Functions of interneuron's:

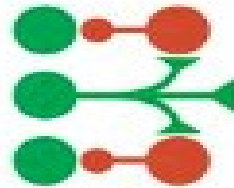
a-Divergence: to magnify spread of response.

b-Convergence: to magnify intensity of stimuli.

c-After discharge: to maintain response.

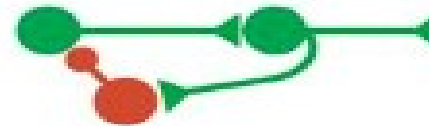
d-Interneuronal inhibition

Lateral inhibition

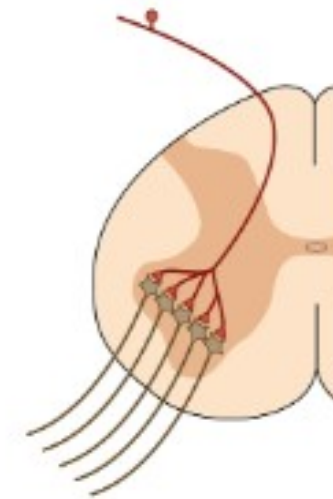


Feedback/Recurrent inhibition

E1



A Divergence



B Convergence



<https://nba.uth.tmc.edu/neuroscience/m/s1/introduction.html>

Properties of reflex Action



- 1- Forward conduction.
- 2- Reflex delay
- 3- Reflex fatigue
- 4- Summation.
- 5- Irradiation & rebound.
- 6- Reciprocal innervation.
- 7- Recruitment.
- 8- After discharge.
- 9- Discharge zone & Subliminal fringe.
- 10- Facilitation.
- 11- Occlusion

Properties of reflex Action



1) Law of forward conduction:

Impulses pass from **pre**-synaptic to **post**-synaptic and not in the opposite direction. (Unidirectional flow).

2) Reflex delay:

-Reflex time: Time between **stimulation** of receptor and **response**.

(Time in **afferent** + **Central time** + **Efferent**)

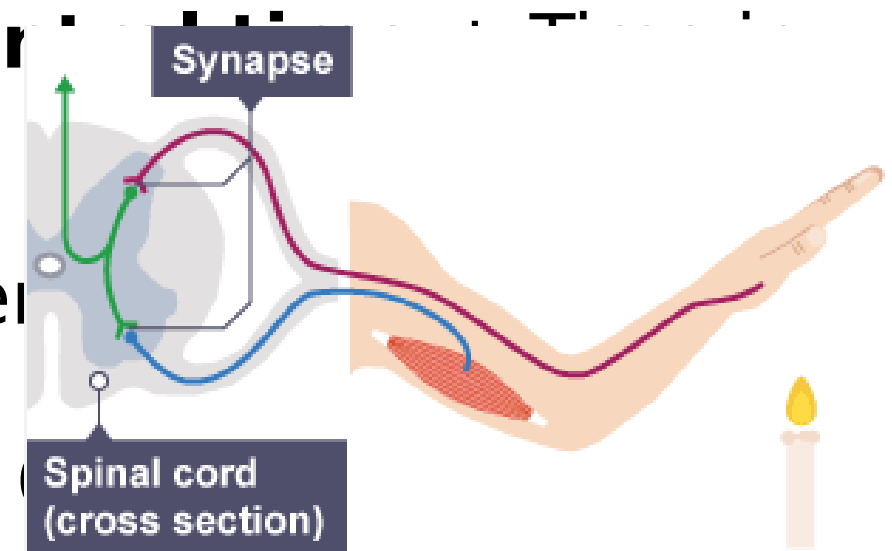
-Central time:

Reflex time - (time in afferent + in efferent)

- Synaptic Delay:

The time taken by only one synapse =

- No. of synapses: **Central time/synaptic delay.**



Properties of reflex Action



3) Fatigue:

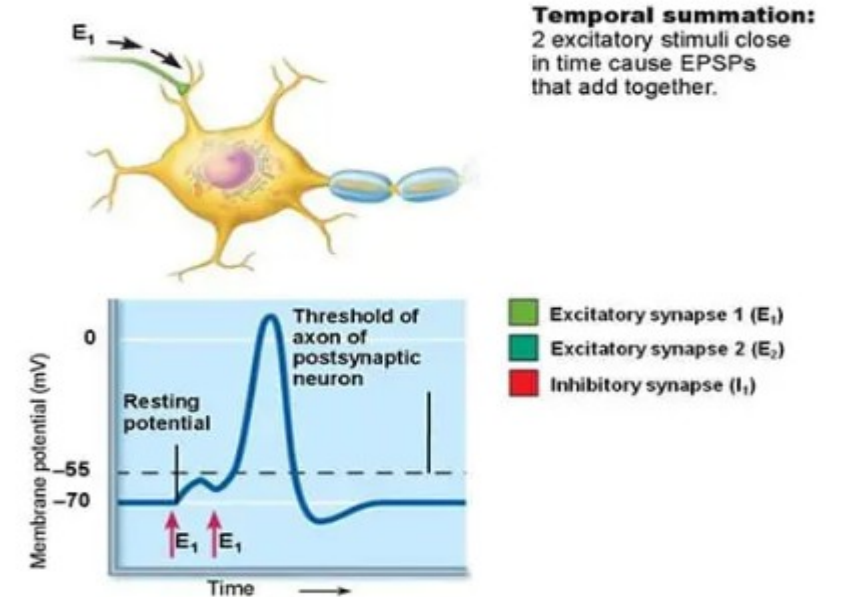
Due to exhaustion of chemical transmitter.

4) Summation

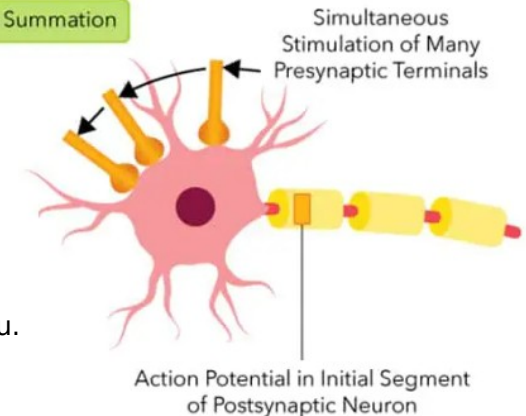
1-Temporal: By repetitive stimulation of the **same** neuron at frequent times on the condition that time between each 2 successive stimuli is **less than 15 msec.** (EPSP).

2-Spatial: Stimuli from different levels at the **same time**, e.g. micturition reflex.

TEMPORAL SUMMATION (EPSPS)



Spatial Summation



<https://www.assignments4u.com/temporal-vs-spatial-summation/>

Properties of reflex Action



5) Irradiation:

The strong stimulus activates not only the primary neural pathway involved in the reflex but also adjacent neural pathways, leading to a more widespread response (depends upon **divergence**). e.g. Flexor withdrawal reflex.

Rebound:

It is state of exaggerated response after initial period of inhibition.

- a) After mosquito bite, if we do pin prick, this causes temporary inhibition of scratching followed by exaggerated scratching.
- b) During crossed extensor reflex, if we do stimulation of the sole of the extended limb, this causes exaggerated extension of the flexed limb.

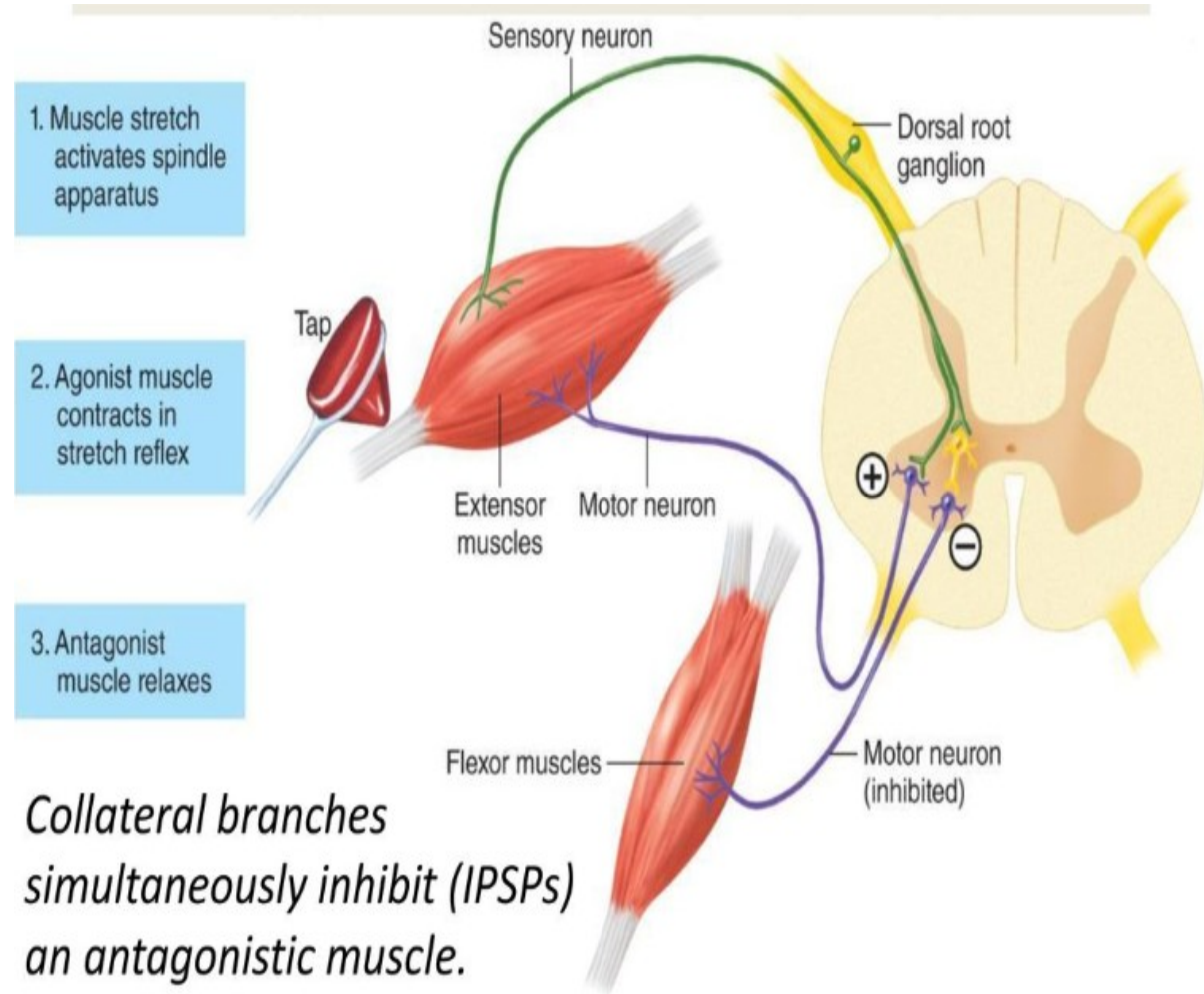
Properties of reflex Action



6) Reciprocal innervation

-Simultaneous contraction of certain group of muscles and relaxation of their antagonist, this is done by reciprocal inhibition circuits.

-This property is present in all reflexes **except positive supporting reaction.**



Properties of reflex Action



7) Recruitment:

It is the progressive activation of motor units in response to an increasing stimulus intensity.

Mechanism

1-Threshold Stimulation: A weak or subthreshold stimulus initially activates a minimal number of motor units which are the most easily excitable.

2-Increasing Stimulus Intensity: As the stimulus intensity increases, more motor units are recruited.

3-Henneman's Size Principle: motor units are recruited in an orderly manner, starting with smaller, lower-threshold motor units and progressing to larger, higher-threshold motor units. This principle ensures a smooth and graded recruitment pattern.

N.B:

Motor Unit: A.H.C.+ its axon+ no of muscle fibers supplied by this axon.

Properties of reflex Action



8) After discharge

It is continuation of discharge (response) after removal of the stimulus.

Examples:

(I) RAS (arousal and alert states):

Arousal response is due to collateral impulses (Visual, auditory & proprioceptive → stimulation of RAS → stimulation of thalamus → stimulation of C.C.

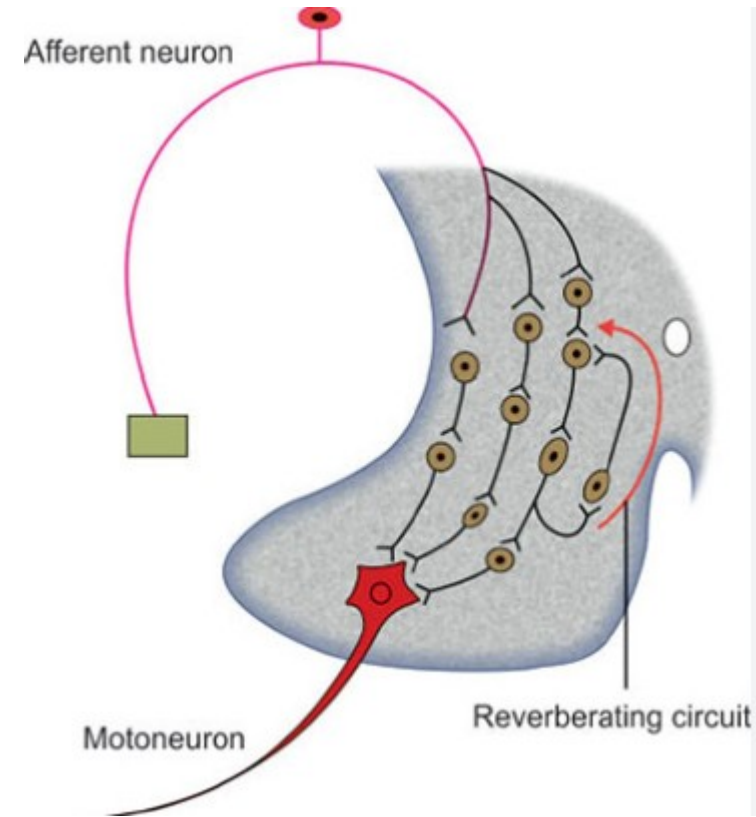
For alert state: continuation of a wakefulness after removal of collateral impulses, caused by + ve feedback mechanism.

(II) Short term memory:

Continuation of storage of information's after removal of the stimulus, and it is removed only by stronger stimulus.

(III) Flexor withdrawal reflex:

Continuation of flexion of elbow & shoulder joints



Properties of reflex Action



Mechanism:

(I) Synaptic after discharge:

It is **E.P.S.P.** which lasts for **15 msec** after removal of sub-threshold stimulus.

(II) Interneuronal after discharge:

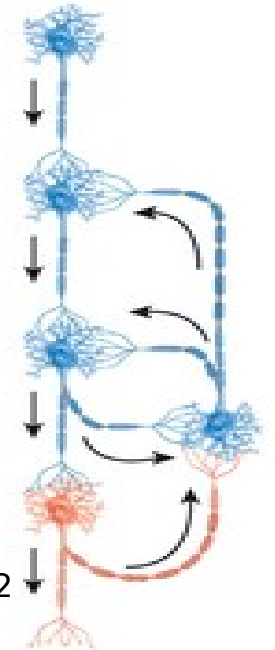
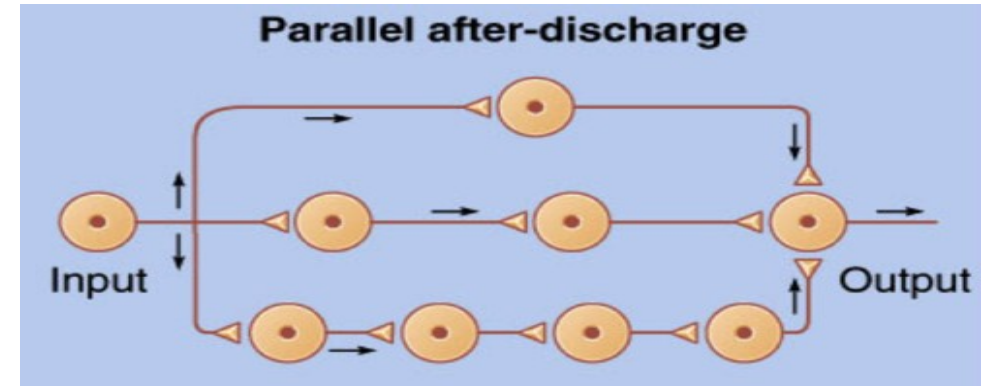
1-Parallel chain (open circuit):

Interneuron's connected with each other in parallel with intervening synapses, each synapse causes delay of 0.3-0.5 msec. Sudden removal of the stimulus doesn't cause sudden relaxation of the muscle.

2-Re-verbration (closed circuit):

Interneuron's are connected with each other in series. These are responsible for prolongation of response.

e.g. **cerebellum**

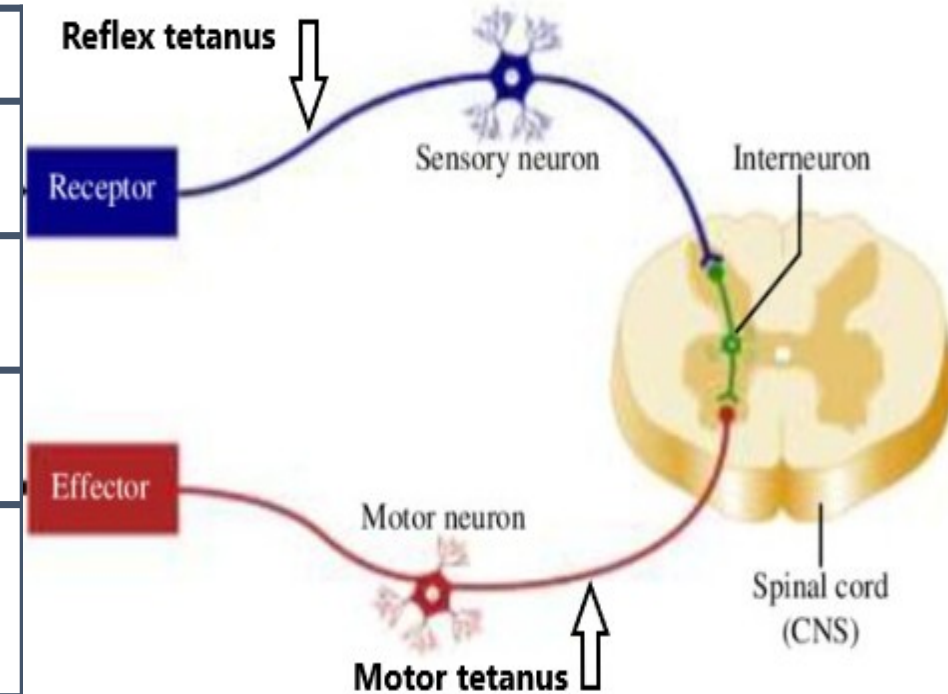


<https://pressbooks-dev.oer.hawaii.edu/anatomyandphysiology2021/chapter/12-nervous-tissue/>

Properties of reflex Action



	Motor Tetanus	Reflex Tetanus
1.Cause	Stimulation of efferent	Stimulation of afferent
2. After discharge	Absent	Present
3. Recruitment	Absent	Present
4. Delay (latent period)	No	Central



Properties of reflex Action



9) Discharge zone Subliminal fringe:

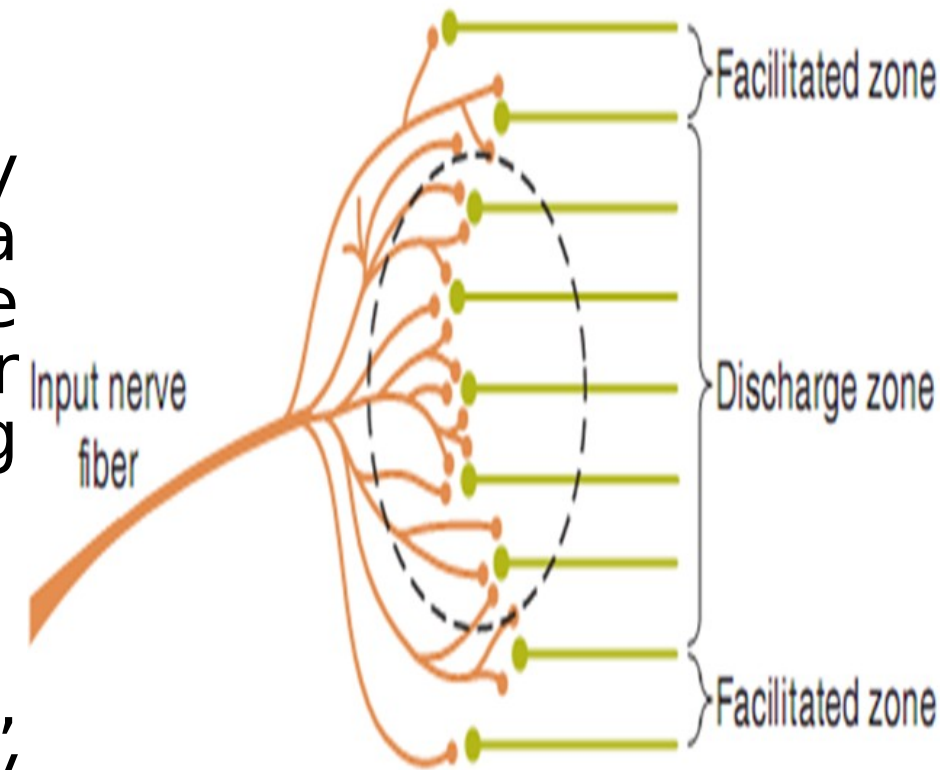
An afferent nerve fiber divides into many hundred terminal branches. Of these, a large number may terminate on one efferent neuron, while a smaller number terminate on other efferent neuron lying nearby.

-Discharge zone:

When an afferent neuron is stimulated, the **central** neurons that have many presynaptic terminals are excited to **threshold** level and AP is fired.

-Subliminal fringe (Facilitation zone):

Neurons in the **peripheral** zone are excited to **subthreshold** level only (their



Guyton and Hall, 2016

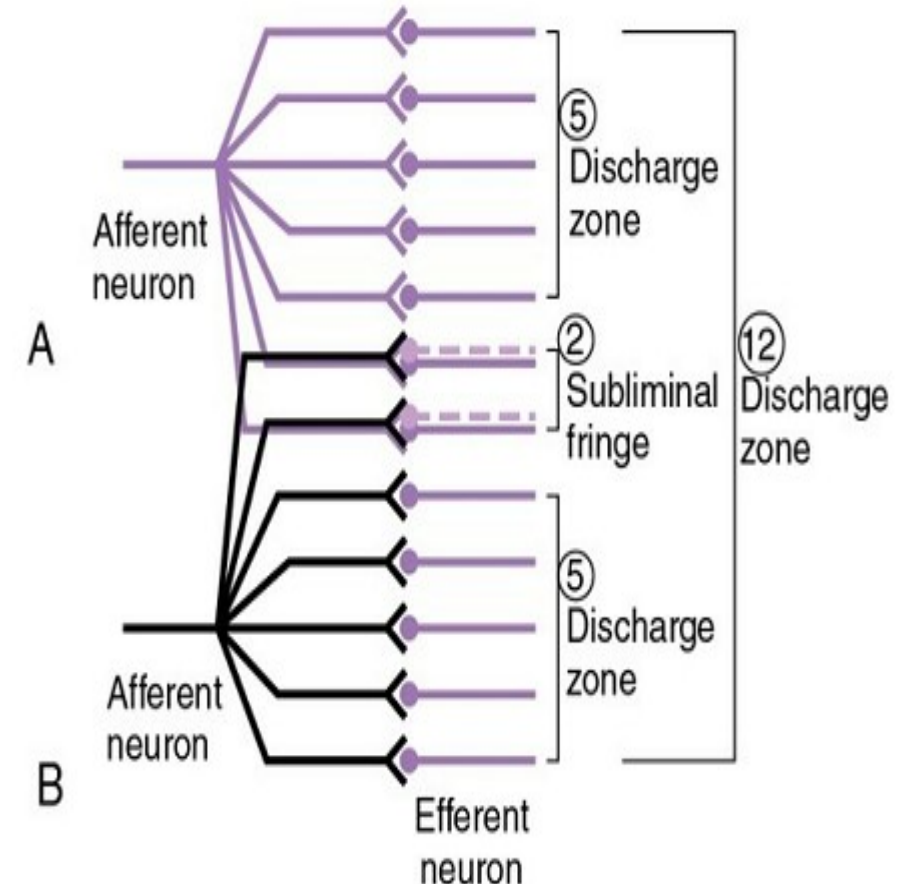
Properties of reflex Action



10) Facilitation:

Because of subliminal fringe effect, stimulation of 2 nearby neurons with common peripheral interneuron with 2 **submaximal** stimuli gives → better response with **synchronous** stimulation (at the same time).

It depends upon **spatial summation**, e.g. micturition



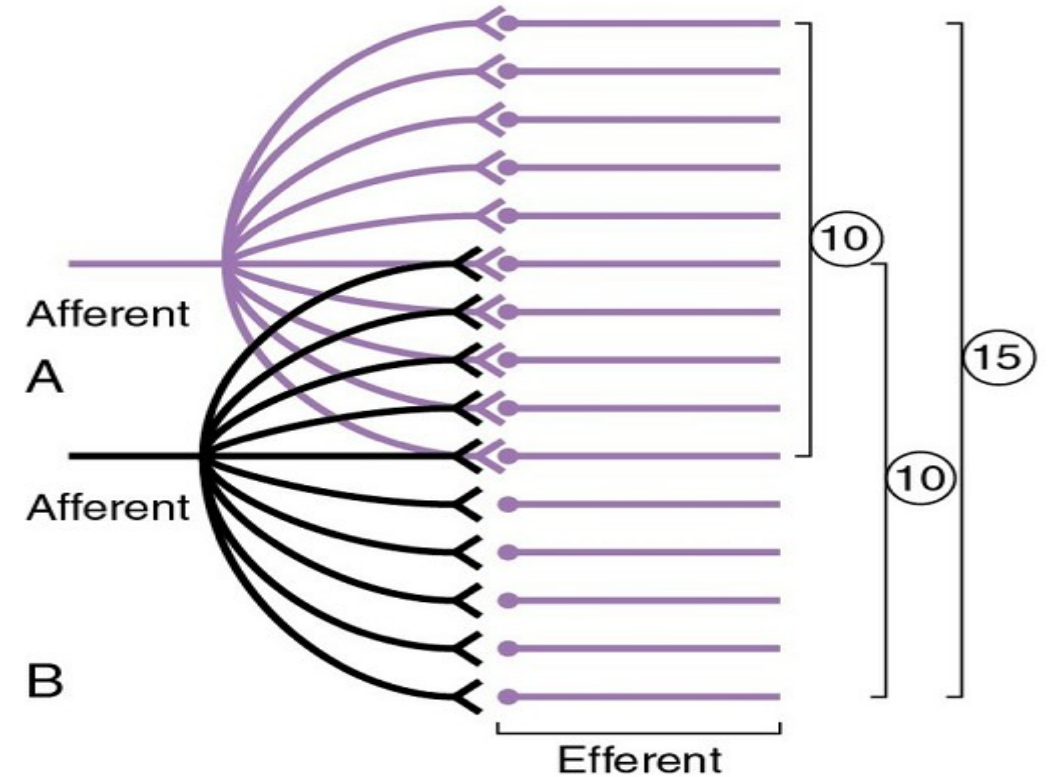
Textbook of Medical Physiology, SECOND EDITION, Indu Khurana, MD, 2015, Elsevier

Properties of reflex Action



11) Occlusion:

Stimulation of 2 nearby afferents with 2 **maximal stimuli** gives → better response with **Asynchronous** stimulation.



Textbook of Medical Physiology, SECOND EDITION,
Indu Khurana, MD, 2015, Elsevier



1- Which of the following is true about total reflex time?

- A. Needed from application of a stimulus to a receptor and the appearance of reflex contraction of a muscle.
- B. Needed from the entry of the nerve impulse in the spinal cord and its exit from it
- C. Needed for transmission of impulses across synapses.
- D. Needed for transmission of a neuronal signal from a presynaptic neuron to a postsynaptic neuron.
- E. Needed for transmission of a neuronal signal across interneurons.



2- The after discharge in a neural pool is based mainly upon which of the following?

- A. After discharge of individual neurons.
- B. Reverberating & parallel interneuron circuits.
- C. Convergence & divergence circuits.
- D. Occlusion.
- E. Recruitment.

Summary



- Reflex arc is the functional and structural unit of CNS.**
- Law of forward conduction: Impulses pass from pre-synaptic to post-synaptic and not in the opposite direction. (Unidirectional flow).**
- Time between stimulation of receptor and response is called Reflex time.**
- Fatigue is Due to exhaustion of chemical transmitter.**
- Summation is either temporal or spatial.**
- Irradiation is increasing the response with increased intensity of the stimulus.**
- Reciprocal innervation is simultaneous contraction of certain group of muscles and relaxation of their antagonist.**
- Recruitment is the gradual contraction of the muscle, inspite of sudden maximal stimulation.**
- After discharge is continuation of discharge (response) after removal of the stimulus.**
- Because of subliminal fringe effect, stimulation of 2 nearby neurons with common interneuron with 2 sub-maximal stimuli gives better response with synchronous stimulation.**

SUGGESTED TEXTBOOKS



1. Guyton and Hall textbook of medical physiology, thirteenth edition 2016, Elsevier, chapter 47, from page 595 to 606.



Thank You